地球物理学报　2007 50 (1): 320-326　ISSN: 0001-5733 CN: 11-2074/P

论文

频散介质中地质雷达波传播的数值模拟

刘四新, 曾昭发

1 吉林大学地球探测科学与技术学院，长春130026 2 沈阳航空工业学院, 沈阳110034

收稿日期 2005-10-12 修回日期 2006-9-28 网络版发布日期 接受日期

摘要　地质雷达所探测的地球介质常常具有频散性．为了研究地质雷达在频散介质中的探测能力，提出了频散介质中时间域有限差分法计算麦克斯韦方程的方法，给出了满足Debye关系的频散介质中的电位移和磁场的迭代算法，以及由电位移计算电场的算法．只有在电场计算时才用到介质的物性参数．提出一种新的吸收边界条件的算法，通过增加假想的介电常数和磁导率，实现了吸收层中波的无反射衰减，克服了以往Berenger完全匹配层计算时对场进行分裂带来的麻烦，从而提高了计算效率．计算实例表明，频散介质中电磁波的衰减更快，测量信号变得很弱．

关键词　地质雷达　麦克斯韦方程　时间域有限差分　频散介质

分类号

DOI:

Numerical simulation for Ground Penetrating Radar wave propagation in the dispersive medium

LIU Si_Xin, ZENG Zhao_Fa

1 College of Geo_Exploration Science and Technology, Jilin University, Changchun 130026, China 2 Shenyang Institute of Aeronautical Engineering, Shenyang 110034, China

Received 2005-10-12 Revised 2006-9-28 Online Accepted

Abstract The earth material probed by Ground Penetrating Radar (GPR) is often dispersive. To investigate the detecting capability of GPR in the dispersive medium, we propose a Finite Difference Time Domain (FDTD) method to solve Maxwell　s equations. We give an iterative method for calculation of the electrical displacement and magnetic fields in the Debye medium, and a method to compute the electric field from electrical displacement. The physical parameters are used only in calculating the electric field. A new absorbing boundary algorithm is introduced by adding a fictitious dielectric constant and magnetic permeability，therefore the wave can be attenuated without reflection in the absorbing layer. This method overcomes the troublesome caused by field split in Berenger　s Perfectly Matched Layer (PML), so that the computing efficiency is increased. Examples demonstrate that the electromagnetic wave in the dispersive medium attenuates very fast and the measured signals are very weak.

Key words Ground Penetrating Radar; Maxwell　s equations; Finite difference time domain; Dispersive medium

---

通讯作者:
liusixin@jlu.edu.cn
作者个人主页: 刘四新; 曾昭发